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(54) Method of Producing Composite Hard Metal Bodies

(57) A composite hard metal body, consisting of a core and a sheath of different hard metal alloys (e.g. of WC/CO) is made by introducing a presintered core into a prepressed sheath and then sintering to cause the sheath to shrink on to the core. The composite body may be subsequently subjected to hot isostatic pressing.

GB 2 017 153 A

FIG. 1a

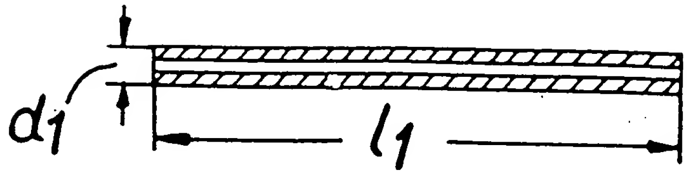


FIG. 1b

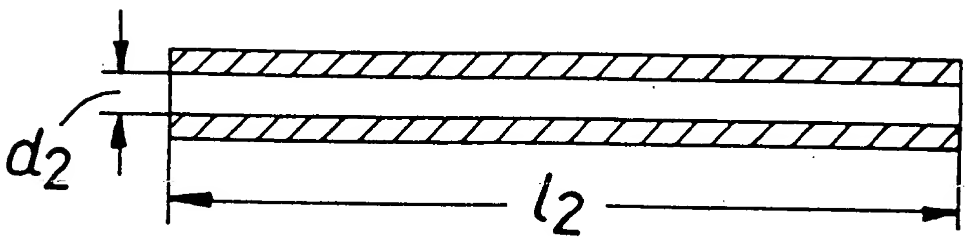


FIG. 1c

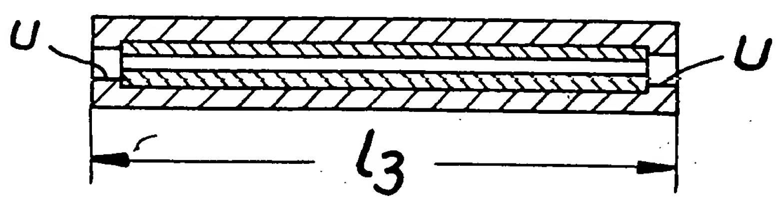


FIG. 2a

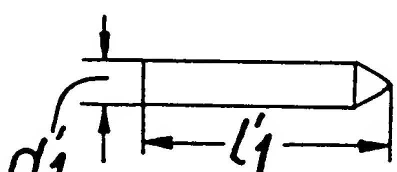


FIG. 2b

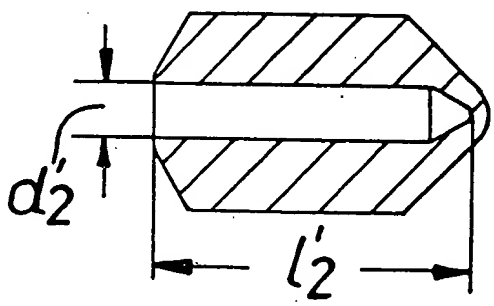
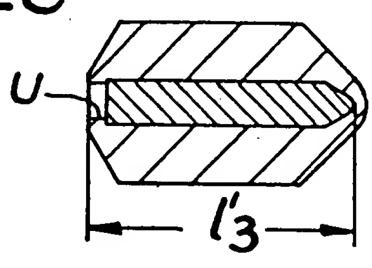


FIG. 2c



SPECIFICATION

Method of Producing Composite Hard Metal Bodies

The invention relates to a method of producing composite hard metal bodies which consist of a core and a sheath of different structure and composition. Such composite hard metal bodies are used for example in stone working and as drawing dies.

German Specification 615262 describes a drawing die of hard metal alloy which can be made in two ways. It can be made by manually pressing a suitable quantity of a relatively ductile alloy gently into the base of a graphite mould which is open at one end. A corresponding amount of a hard and brittle alloy is then poured in and gently pressed and the contents of the mould are sintered under pressure. Alternatively the core of the drawing die may first be formed by pressing, sintering or casting and then embedded in powdered more ductile alloy which is contained in a graphite mould open at one end. Finally the mixture of core and powder is pressed and sintered. This method of production has disadvantages referred to, inter alia, in German Specification 899481. Owing to the different coefficients of expansion stresses occur between the zones of hard metal of different softness which cause cracks at the zone boundaries and increased susceptibility to corrosion. It has been proposed to remove the risk of cracking for the harder portion to be made shorter in the longitudinal direction of the cutting edge and enclosed so far as possible by softer material. The text does not describe how such boring bits are to be made.

German Specification 1053447 describes hard metal cutting inserts for rock drills having a zone of harder and a zone of less hard but more ductile hard metal which are characterised by a zone of hard metal, the toughness of which increases from the cutting edge to the base surface. The cutting edge is formed by sintering, the boundaries between the zones being sharp or merging more or less progressively. It is suggested as an alternative procedure first to produce the different zones independently and then to unite them in a suitable manner, for example by soldering but no information is given as to how the hard metals to be combined are produced. However, hard metals of different composition produced by sintering or with auxiliary aids, such as graphite moulds and hot pressing, have cracks at the zone boundaries caused by stresses.

The object of the invention is to provide a method of producing composite hard metal bodies of different composition which obviates the disadvantages of the known methods.

This object is fulfilled in accordance with the invention in that the already sintered core is inserted into the prepressed sheath and the sheath is then shrunk on to the core by sintering. Advantageously the sheath is shrunk on to the core on sintering to an extent greater than the amount by which the opening in the sheath exceeds the diameter of the core. The cross sections of the opening in the sheath and of the core prior to sintering are such that smooth insertion of the core into the sheath is possible. The cross section of the opening in the sheath should, however, exceed the diameter of the core by at least 35%, it is preferably greater by 10—20%. It is also advantageous so to select the geometric dimensions of the sheath and the core that the length of the sheath before sintering is sufficiently greater than the length of the core to ensure that after sintering the length of the shrunk sheath still exceeds the unaltered length of the core. This ensures complete enclosure of the surface of the core by the sheath which, in combination with the shrinkage of the opening in the sheath, forms the end closures for the core. Such composite hard metal bodies may be subsequently subjected to isostatic compression at 1200—1450°C, preferably 1300°C.

A particular advantage of the method described is that, surprisingly, by shrinking the pressed part to the sintered part by the amount specified in the claims an intimate bond is achieved between the two parts without occurrence of harmful influences, such as crack formation and throughgoing diffusion passages. As in producing hard metals the sintering temperature largely depends on the content of binder and the grain size of the introduced binder, fine grained alloys with a low cobalt content require a very much higher sintering temperature than alloys containing coarse grains of carbide and a large amount of cobalt. Advantage is taken of this knowledge in that fine grained alloys of low cobalt content are used for the core and alloys containing coarse carbide grains and a large amount of cobalt are used for the sheath. By the present invention each hard metal in the composite body can be sintered at the optimum temperature. The union of the hard metals takes place only at the temperature at which the sheath is shrunk, namely a lower temperature than that required for sintering the material of the core.

When the geometrical measurements of the core and sheath are selected in accordance with the claims, an envelopment of the ends of the core is achieved whereby, e.g. in fabrication of tubular composite bodies, the bore of the core remains with advantage open at both ends.

It is, however, also possible to use a pressed body open at one end, the sintered core being introduced into the cavity and the sheath having a length taking account of shrinkage in length of the sheath. The result is the desired enclosure of the ends of the core, which is determined solely by the difference in measurements of the core and sheath and can be exactly controlled.

If it is desired to increase the ultimate stress values of the hard metal body, it is subjected to isostatic compression at a temperature in the range of 1250—1450°C, preferably 1300°C,

whereby diffusion in the cobalt phase is held to a minimum.

Embodiments of the invention are illustrated in section of the drawing, in which:—

Figure 1*a* shows a tubular extruded and afterwards sintered core,

Figure 1*b* shows a pressed sheath,

Figure 1*c* shows the hard metal core and the pressed sheath combined by shrinkage to a composite hard metal body,

Figure 2*a* shows a core constituted by a sintered pin,

Figure 2*b* shows a pressed sheath open at one end, and

Figure 2*c* shows the core and sheath combined by sintering to form a composite hard metal body.

Figure 1 shows a tubular extruded and afterwards sintered core of composition 94% WC, 6% Co having an initial mean grain size of 1.2 μm, hereinafter termed alloy 1 and of dimensions d_1 and l_1, as shown in Figure 1*a*. This core is inserted in an extruded and afterwards dewaxed sheet of the composition 90% WC, 10% Co, initial mean grain size 4 μm, hereinafter termed alloy 2 and of dimensions d_2 and l_2 (Figure 1*b*) so that after finish sintering of the composite body, as shown in Figure 1*c*, the core lies centrally in the sheath, which has a length l_3. The diameter d_2 (2.76 mm) of the bore of the shell was about 20% greater than the diameter d_3 (2.3 mm) of the core. The shrinkage of the sheath achieved by sintering was 35%. The envelopment U of the ends of the core arising from the sintering operation was due to the diameter d_1 of the core remaining unaltered whereas the shrinkage of the sheath was in excess of the excess diameter of its bore. If l_3 is the length of the sintered core, l_2 the length of the shell before sintering and l_1 is the length of the sintered core, the following relationship holds good:

$$l_2 > l_3 > l_1$$

After shrinking during sintering of the composite body the length of the shell is therefore greater than the length of the core. In the concrete example selected in Figure 1 l_2=108 mm, l_3=50 mm and l_1=72 mm. The extent of projection of the shell is therefore 4 mm. This amount is, in principle, freely selectable but should not be less than 1 mm to ensure satisfactory and repeatable results.

The bond between the core and the sheath was free from faults and the properties of the alloys used were largely unaffected as will be seen from the following table:—

		Individually Sintered	In the composition body
HV30	Alloy 1	1550	1502
	Alloy 2	1295	1315

HV30 is the Vickers hardness measured under a force of 30 kp/mm².

The composite body exhibited excellent properties of ductility which were generally in excess of the basic bending strength of the starting alloys. Thus the desired bending strengths of alloys 1 and 2 were 150 daN/mm² and 220 daN/mm² while the bending strength of the composite body was 234 daN/mm². A composite body was therefore obtained which, when subjected to abrasion, e.g. in drilling, had high wear resistance but nevertheless had the ultimate tensile properties of a ductile hard metal. Among other fields of use it finds application as a journal in the yarn producing industry.

Figure 2 shows application of the method according to the invention to a composite body which is formed from a pressed sheath open at one end and a sintered core. The core pin has at one end a rounded conical taper, a diameter d_1' of 3.2 mm and a length l_1' of 17 mm. The alloy consisted of 94% WC and 6% Co, with an initial particle size of WC of 1.2 μm. The core pin was sintered at a temperature of 1540°C.

The pressed sheath open at one end shown in Figure 2*b* was of an alloy of composition 92% WC, 8% Co and an initial grain size of WC of 3.5 μm and had a form corresponding to that of the core but of larger size. The depth l_2' of the pressed in recess was 21.8 mm and the diameter d_2' of the recess was 3.6 mm. The ratio of d_2' to d_1' was therefore 1.125. The diameter of the unsintered shell is 20% greater than the diameter which is achievable by sintering without an inserted core. Sintering the shell with an inserted core causes the shell to shrink on to the core. After sintering of the composite body the ends of the core were well enveloped. The length l_3' of the sheath after sintering was 18.2 mm, so that it had a projecting length of 1.2 mm. The bodies where bonded together without cracks and again there was no significant change in the properties of the alloys 1 and 2.

Drilling heads for percussion rock drills equipped with composite hard metal pins made in this manner were tested under the most serious conditions of abrasion. While drilling heads carrying composite hard metal pins made by a known process had an average life of 320 m, drilling heads carrying composite hard metal pins produced in accordance with the invention had an average life of 430 m. This demonstrates again how well the hard metal alloys used retain their properties when the composite hard metal is produced by the procedure described.

It is also possible to produce rings consisting of a core ring and a sheath ring. Rings produced in accordance with the invention have a perfect bond between the sheath and the core with a sharp boundary between the alloys.

It is also possible to apply the invention to a main body of ductile hard metal having several cavities for receiving hard metal cores. After sintering of the composite body the edges of the cores are tightly enclosed and there is an excellent bond between the individual cores.

Claims

1. A method of producing composite hard

metal bodies, consisting of a core and a sheath of different hard metal alloys, characterised in that the already sintered core is inserted into the pre-pressed sheath and the sheath is then shrunk on to the core by sintering.

2. A method according to claim 1, characterised in that the cross section of the opening in the sheath before sintering is sufficiently large to permit insertion of the core but does not exceed the diameter of the core by more than 35%.

3. A method according to claims 1 and 2, characterised in that the cross section of the opening in the sheath before sintering is 10% to 20% greater than the diameter of the core.

4. A method according to claim 1, characterised in that a core is inserted into a sheath of greater length and then sintered and in that after sintering the length of the shell is greater than the unchanged length of the core.

5. A method according to claim 1, characterised in that the hard metal body is compressed isostatically at a temperature of 1250—1450°C, preferably 1300°C, after sintering.

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